R&D investment in green building initiatives in Western Australia

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SUMMARY

This paper reports on a current case study of green building initiatives implemented by the Western Australian government in the past decade. The intent is to provide a qualitative understanding of past R&D investments in the Australian built environment.
The case method was selected to illustrate three sector-based investments, one of which is reported on here.
The conceptual framework underpinning interview design and data analysis uses dynamic capability, absorptive capacity and open innovation theories to better understand the organisational environment in which these initiatives were implemented. Data has been thematically coded to criteria identified from the literature to illustrate organisational characteristics which may have contributed to dissemination and impact.
The results will be combined with two further case studies (construction safety and digital modelling), to inform this research. This industry supported project will conclude by developing policy guidelines for future R&D investment in the built environment.

KEYWORDS
Green buildings, R&D investment, R&D diffusion and impact, urban infrastructure

1 INTRODUCTION

This paper reports on current research to improve the management, diffusion and impact of R&D investment in the Australian built environment. This paper outlines findings of the green building case study being undertaken in partnership with the Western Australian Government (WAG). The intent is to develop guidelines for interaction and investment that maximise the value of R&D investment in the built environment and like industries. These guidelines will be based on: an analysis of past investment; lessons learned in diffusing research outcomes into public and private industry practice; and improved understandings of the nature of future industry trends and research needs.
Two broad segments of research have been designed to: (i) develop an industry R&D roadmap and policy guidelines for R&D investment in the Australian built environment; and (ii) contribute to new knowledge in this field.

Retrospective evaluation and prospective value-add
The retrospective component of this research encompasses two phases. The first is an audit and analysis of past R&D investment from 1990 to 2008. This has involved an analysis of data from: the Australian Bureau of Statistics; the Organisation for Economic Cooperation and Development Database for Structural Analysis; and the Australian Research Council. The second comprises three case studies investigating specific investments across three themes including: road construction safety; green buildings; and CADD to Integrated Project Delivery. These case studies are intended to illustrate: (i) how past R&D investment has been invested, with what outcomes and impacts; (ii) mechanisms and processes through which R&D was delivered and translated into practical outcomes; (iii) success, challenges and

lessons learned; (iii) whole-of-industry benefits; and (iv) pathways for success in the R&D provider/industry relationship.

There are two phases of activity in the prospective component being: (i) strategic foresighting using industry roadmapping, semi-formal interviews and focus groups with industry experts and stakeholders; and (ii) developing policies for use by private and public organisations to better leverage future investments. The fundamental premise is that every effort must be made to maximise the end-user value of each dollar of R&D funding to the built environment industry. This efficiency perspective is underpinned by anecdotal evidence (to be informed through this research) that built environment industry research is underfunded and does not receive public research funds befitting the importance that construction and other built environment sectors play in the Australian economy.

The green building case study

The Western Australian Government has taken a leadership role for a number of decades in developing more environmentally responsive buildings. In the past decade, a number of substantial initiatives have been introduced to green the stock of government buildings and provide broader industry leadership. This case study investigates: the nature of this leadership; drivers for R&D initiatives developed and implemented in the past 10-15 years; influences of R&D from other sectors/disciplines; the nature and extent of collaboration and knowledge exchange; and the dissemination and impact of initiatives

2 RESEARCH METHOD

Two research questions provide the context for the design of this research:
(i) What are the success criteria and critical challenges which impact on the diffusion of R&D investment to the Australian built environment?
(ii) What policy directions and initiatives can be developed to better leverage this R&D investment?

Conceptual framework

The conceptual framework for this research is built around dynamic capabilities, absorptive capacity and open innovation theory. These concepts have been used to guide the research design in order to provide valuable insights in the policy and guideline development phase of the project.

Teece, Pisano and Shuen (1997) discuss *dynamic capabilities* 'as the firm's ability to integrate, build, and reconfigure internal and external competencies to address rapidly changing environments' (p.516). Criteria for discerning evidence of an organisation's dynamic capabilities have been drawn from several key conceptual papers in this field.

Cohen and Levinthal (1990) introduce the concept of *absorptive capacity* as a 'firm's ability to recognise the value of new, external information, assimilate it, and apply it to commercial ends' (p.128). Zahra and George (2002) discuss four dimensions of this capability being knowledge acquisition, assimilation, transformation and exploitation (p.186). Key criteria which shed light on the absorptive capacity of an organisation have been drawn from these and other key papers in this field.

Chesbrough (2004) defines the *open innovation* paradigm as assuming 'that firms can and should use external as well as internal ideas, and internal and external paths to market, as they look to advance their technology'(p.23), thus increasing the number of possible sources of innovation. Again several key conceptual papers in this field have been drawn upon to establish criteria for thematic coding of interview responses.

Data-gathering

The case study method is being used to undertake illustrative case studies of three initiatives to illustrate the nature of past R&D investment. Multiple sources of information were used to inform this case study including: (i) meetings with agency staff; (ii) documentation including policies, strategies and guidelines; (iii) formal interviews; (iv) academic literature in the field; and (v) industry reports and presentations. Thirteen formal interviews of between 30minutes and 1 hour in duration were undertaken between July and September 2011. Five of the interviewees were employed by WAG including people from executive to agency implementers. Eight people were external to WAG and included suppliers, consultants, researchers, a contractor and an industry association representative. Fourteen structured questions were asked in a formal interview environment to inform the following analysis.

Interview data analysis

Criteria derived from the conceptual papers have been used to guide the thematic coding used in the data analysis phase. This was a two-step process. Firstly summary tables were developed of interview responses (from notes, observations and transcripts) relating to: (i) issues directly addressed in the interview questions; and (ii) issues raised by interviewees in addressing interview questions which were considered to be of relevance to the theory underpinning this research. Secondly these tables were further analysed from two perspectives:

(i) The researcher established key themes based on an analysis of the interviewees' responses to each of the questions. This was done to identify drivers, barriers, successes and the like for each of the cases.

(ii) The researcher grouped responses into characteristics which could be identified with specific aspects of dynamic capabilities, absorptive capacity, and open innovation theory, particularly in relation to evidence and measures.

These thematic groupings were verified (via random sampling) by an alternate independent research team member to ensure the reliability and trustworthiness of the coding.

3 RESULTS

Three components of results have been compiled including: (i) a narrative which brings together information from documentation and interviews to 'tell the story'; (ii) a collation of drivers, implementation activities, impacts and the like, from the direct responses to interview questions (this data is not presented here due to space constraints); and (iii) a compilation of thematically coded responses relevant to the underpinning theories.

The narrative

A broad cross section of people from within WAG have been identified as responsible for driving and delivering on green building initiatives from 2001 (the time frame for most responses related to post 2001) including: (i) Past Premier Dr Geoff Gallop (2001-2006) through the establishment of the Sustainable Policy Unit in 2002; (ii) staff from across 42 divisions who contributed to the State Sustainability Strategy (2003); (iii) WAG Departments including Works and Housing, Planning and Infrastructure, and Education; and (iv) WAG agencies including LandCorp.

This recent focus has been underpinned by a long-term awareness of such issues (e.g. the publication of *Energy Management in the Design of New Buildings* in 1980. In the past decade several publications have been informing this development (**Figure 1**), many as an outcome of the formation of the Sustainable Policy Unit (supported by a whole-of-government approach) in 2002.
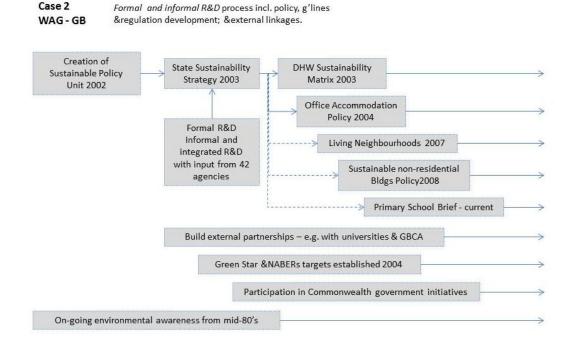
Figure 1 – Green building pathway

Further drivers were provided by national initiatives including: *National Strategy on Energy Efficiency* (an initiative of the Council of Australian Governments); the *Energy Roundtable*; *Online System for Comprehensive Activity Reporting (OSCAR)*; the Australian Building Codes Board and developments in the environmental and sustainability provisions of the *Building Code of Australia*; and the *Solar Cities program*.

The establishment of *National Australian Built Environment Rating System (NABERS -* formerly known as Australian Building Greenhouse Rating) and *Green Star* rating scheme (in 2003) through the *Green Building Council of Australia* (GBCA) have also provided crucial tools to enable government and industry to quantify outcomes. Through mandating the use of these tools the WA Government also provided a critical lever for achieving enhanced environment (and social) outcomes in the built environment.

Additional leverage has been achieved through the establishment of relationships with external parties. These include: other state and local planning authorities; research institutions; industry and supply chain; and industry associations.

Links to theory derived from interview data

The following tables (Tables 1-4) are provided as examples of data gathered, and draw upon criteria identified in key literature relevant to dynamic capabilities, absorptive capacity and open innovation used by the research team to code interviewee responses.

For example, in Table 1 the majority of the interviewees (in this case all of them) made comments which researchers considered relevant to product or process development; organisational learning and external R&D engagement; whereas only a minority of the interviewees (in this case only 2 of them) made comments which were considered relevant to IP creation.

Table 1 – Evidence of dynamic capabilities

Majority of interviewees	Product or process development; Organisation learning; External R&D engagement
Several interviewees	Internal R&D engagement; Product or service differentiation; Cost advantage through less waste; Strategic decision making
Some interviewees	Technology transfer; Alliancing; Customer focus
Minority of interviewees	IP creation; Cost advantage through increased market intelligence

Majority = >80%; Several = >50 but < 80%; Some = <50% but >20%; Minority = <20%

Table 2 - Evidence of inbound absorptive capacity

Majority	Exploitation of knowledge; Assimilation of knowledge into organisation; Transfer of knowledge; Knowledge acquisition from external sources; Knowledge acquisition – internally generated

Majority = >80%; Several = >50 but < 80%; Some = <50% but >20%; Minority = <20%

Table 3 - Features of open innovation

Majority	New metrics for assessing innovation capability and performance; Purposive outbound flows of knowledge & technology
Several	Business model focus on converting R&D into commercial value; Abundant underlying knowledge landscape; Rise of innovation intermediaries
Some	Equal importance given to external knowledge, in comparison to internal knowledge
None	Proactive and nuanced role of IP management

Majority = >80%; Several = >50 but < 80%; Some = <50% but >20%; Minority = <20%

Table 4 - Nature of open innovation - effectiveness

Several	Financial benefits
Some	Less waste; Decreasing risks; Lower costs; Enhancing technological effectiveness; Access to new markets; Stimulating growth
Minority	Shorter time to market; Number of innovations; Nonfinancial benefits

Majority = >80%; Several = >50 but < 80%; Some = <50% but >20%; Minority = <20%

4 DISCUSSION

Based on an analysis of interview responses, WAG has embedded dynamic capabilities which have facilitated their approach to green building development in that state. These include: the on-going development of new products and processes (such as new policies and guidelines); organisational learning; and engaging with external R&D agencies. This latter capability is further reinforced with evidence of inbound absorptive capacity through the exploitation and transformation and assimilation of knowledge into the organisation. Issues identified from the analysis in relation to identifying measures of absorptive capacity reinforce the effort put into new product development with a focus on cost reduction (for example savings on energy).

In terms of issues relevant to features of open innovation, the majority of interviewees highlighted the availability of new metrics for assessing innovation capability and individuals (i.e. NABERS and Green Star). Purposive outbound flows of knowledge and technology was also important (through both interaction with industry organisations such as the GBCA; and the Building Management and Works/Department of Education's energy monitoring of schools). An abundant underlying knowledge landscapes was also evident from interview responses (such as the 50 PhD's informing the development of the State Sustainability

Strategy), and a rise in the internal knowledge base, linked to the rise of innovation intermediaries in this field. Regarding the nature of this open innovation, the acquisition and exploitation of knowledge was important, and financial benefits were identified as relevant to the effectiveness of this innovation.

Benefits of construction innovation were coded according to criteria related to environmental pressures, technological capability, knowledge exchange and boundary spanning (such as breaking down departmental silos). The most commonly coded responses across these include: innovation stimulating regulation; government clients with innovative demand; pilot projects; the role of product evaluating institutions; the role of integrated and informal R&D; the creation of knowledge networks; the stimulation of research; and the empowerment of innovation leaders.

Those criteria which were coded in the minority or not at all in relation to dynamic capabilities are IP creation and cost advantage through increased market intelligence. With regards to absorptive capacity these are: technical specialisation; taking advantage of economies of scale; range of staff training; and awareness of competitors' technologies. Open innovation criteria least coded include: proactive and nuance role of IP management; shorter time to market; number of innovations; and non-financial benefits. The least coded of the construction innovation criteria are: programs promoting access to technology; technology leadership strategies; technology fusion; technology push; broad view of risk; and mechanisms for sharing financial risks and benefits.

5 CONCLUSIONS

The criteria highlighted above illustrate areas in which past and recent activity has been successful and areas were potential future benefit could be obtained. Each of these require further verification and analysis, but do start to illustrate the nature and benefits of the roll-out of green building initiatives by the Western Australian government.

There was a high level of focus on several criteria. Product and process development was evidenced in the focus on the development of the State Sustainability Strategy and associated documents, regulations and policies, which further informed organisational learning. R&D engagement (both formal and informal) with a cross spectrum of academic institutions and innovation brokers was also critical. Cost advantage and benefits were evidenced in references to enhanced business case development and cost savings associated with increased resource efficiency. Knowledge creation, exploitation and flows were seen in each of the above and also in the use of knowledge in the project context. Financial benefits and cost savings were evidenced in project outcomes through business cases and Requests for Proposals, and a greater focus on resource efficiency. Additionally the availability of new metrics for assessing innovation and performance were highly coded. This is evidenced through the strong focus on green building rating tools to set targets for and report on green building outcomes.

Potential areas for enhancing outcomes typically relate to a possible limited focus on IP; technology; and risk sharing. These will be explored further in conjunction with: the Western Australian Government; the cross-case analysis; and findings of the audit and analysis of past R&D investment in the Australian built environment.

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